heating the bumps to a temperature sufficiently high to form a metallurgical connection at an interface between the bumps and the interconnect points.

14. (Amended) A chip package structure comprising

a chip having a bumps formed thereon and a substrate having interconnect points on a metallization thereon, the bumps forming contacts with the interconnect points, wherein an alloy is formed at an interface between the material of each bump and the material of the interconnect contact in contact with the bump.

REMARKS

Claims 1 and 14 are amended for improved clarity. No new matter is introduced by any of the amendments, and entry thereof is requested.

Restriction was required in this application, and claims 1 - 13 were withdrawn as being directed to a nonelected invention; the restriction requirement is traversed (see below), and Applicants respectfully request examination of all the claims in the application. Claims 1 - 17 are in the application, of which claims 1 - 13 are directed to group I and claims 14 - 17 are directed to group II.

Reconsideration of the application, as amended, is requested.

The specific points raised by the Examiner will now be addressed, beginning with the Restriction requirement.

Election/Restriction

The Examiner required restriction of this application to one of:

I. Claims 1 - 13, said to be "drawn to method of making a chip package structure"; and

II. Claims 14 - 17, said to be "drawn to a chip package structure".

Applicants' **provisional election, with traverse**, to prosecute claims directed to a chip package structure (the subject matter of Group II), **is affirmed**.

The Examiner asserted as the reason for requiring restriction that:

> In the instant case the device of the group II invention could be made by a materially different process. For example, the chip can be aligned with the substrate before providing the polymer adhesive instead of providing the polymer adhesive and then aligning the chip with the substrate.

The restriction requirement is traversed for the following reasons. Applicants agree that the polymer adhesive may be provided either before or following the alignment of the chip with the substrate; but the Examiner has not **shown** how these alternatives would constitute "a **materially** different process", nor has the Examiner provided any other showing that the group I and group II inventions are distinct.

Accordingly, Applicants respectfully request withdrawal of the restriction requirement and examination of all the claims now in the application.

Rejection under 35 U.S.C. § 102(b)

Claims 14 and 16 were rejected under 35 U.S.C. § 102(b) as being anticipated by Scharr *et al.* U.S. 5,346,857 ("Scharr"). With reference particularly to Scharr Figure 2 and Column 3, line 54 - column 4, line 16, the Examiner asserted that:

> Scharr et al. teach a chip (26) having a bumps (28) formed thereon and a substrate (21) having interconnect points (22) on a metallization thereon, the bumps forming contacts with the interconnect points, wherein an alloy is formed at an interface between the material of each bump and the material of the interconnect in contact with the bump.

Applicants disagree with the Examiner's reading of Scharr. Scharr nowhere, neither in Fig. 2 nor at the cited passage, nor anywhere else, describes an alloy formed "at an interface", as in Applicants' invention as claimed. *See*, Applicants' Fig. 1B, reference 26. Particularly, Scharr at Col. 3, lines 63 - 65, referring to Fig. 2, states, "Gold bumps 28 are brought into contact with tin 23. Pressure and heat are applied to the structure ... thereby forming a gold-tin eutectic alloy **in the regions indicated by lines 29**." Thus, Scharr describes forming an alloy in a broad **region**, and not at an interface, as in Applicants' invention.

Scharr asserts in the passage at Col. 3, lines 23 - 39, referring to Fig. 1, regarding the application of heat to form the alloy, that "[a]t temperatures below approximately 280 °C, a gold-tin eutectic will not be formed." According to Applicants' invention an alloy is formed at the

interface at temperatures in a range as low as 200 °C, and preferably at about 232 °C (*See*, Applicants' specification at paragraphs [0006] and [0016]).

Accordingly, this rejection should now be withdrawn.

Rejection under 35 U.S.C. § 103(a)

Claim 17 was rejected under 35 U.S.C. § 103(a) for obviousness over Scharr in view of Zakel *et al.* U.S. 6,153,940 ("Zakel"); and claim 15 was rejected for obviousness over Scharr in view of Nakamura U.S. 6,326,234.

As to claim 17 the Examiner acknowledged that Scharr does "not explicitly teach the alloy at the interface in 20:80 Sn:Au alloy", but asserted that Zakel "teach the alloy at the interface is a 20:80 Sn:Au alloy (column 4, lines 5-7)", and argued that it would have been obvious:

> to incorporate the teaching of Zakel et al. into the device taught by Scharr et al., since the alloy at the interface (20:80 Sn:Au alloy) is conventional.

As to claim 15 the Examiner acknowledged that Scharr does "not teach a cured adhesive polymer is situated in a middle region between the bump surface of the chip and the surface of the substrate", but asserted that "Nakamura teaches a adhesive polymer is situated in a middle region between the bump surface of the chip and the surface of the substrate (see figures 3, 4)", and argued that it would have been obvious:

> to incorporate the teaching of Nakamura into the device taught by Scharr et al., since it is desirable securely to hold the chip and the substrate in place.

This rejection is traversed, for at least the following reasons. First, as noted above, Scharr does not teach an alloy at an interface between the bump material and the interconnect point; moreover, Scharr teaches that an alloy according to the teachings of Scharr will not be formed at the parameters described by Applicants' specification. Neither Zakel (as to claim 15) nor Nakamura (as to claim 17) can supply what Scharr lacks.

Accordingly, it is submitted that neither Scharr nor Zakel nor Nakamura—nor any combination of Scharr and Zakel and Nakamura —makes Applicants' invention. Accordingly, the rejections for obviousness should be withdrawn.

In view of the foregoing, it is believed that all the claims in the application are in condition for allowance, and action to that effect is requested.

This response is being filed within the third month following the shortened statutory period set by the Examiner and, accordingly, it is accompanied by a petition for three months' extension of time and a fee or fee authorization therefor. The Commissioner is authorized to charge any additional fee[s] that may be required in connection with the filing of this paper, or to credit any overpayment, to Deposit Account 50-0869 (Order No. 1002-1).

If the Examiner determines that a conference would facilitate prosecution of this application, the Examiner is invited to telephone Applicants' representative, undersigned, at the telephone number set out below.

Respectfully submitted,

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Attachment under Rule 1.121
(Claims)

The claims are amended as follows.

1. (Amended) A method for providing [metallurgic] connection between a flip chip and a substrate, comprising [comprises]

providing a chip having a set of bumps formed on a bump side thereof;

providing a substrate having a set of interconnect points on a metallization thereon;

providing a measured quantity of a polymer adhesive in a middle region of the chip on the bump side;

aligning the chip with the substrate so that the set of bumps aligns with the set of interconnect points;

pressing the chip and the substrate toward one another so that a portion of the polymer adhesive contacts the substrate and the bumps contact the interconnect points; and

heating the bumps to a temperature sufficiently high to form a metallurgical connection at an interface between the bumps and the interconnect points.

2. (Unchanged) The method of claim 1 wherein the bumps are stud bumps.

3. (Unchanged) The method of claim 1 wherein the bumps comprise gold.

4. (Unchanged) The method of claim 1 wherein the bumps are plated with a metal comprising gold.

5. (Unchanged) The method of claim 1 wherein the interconnect points comprise tin.

6. (Unchanged) The method of claim 5 wherein the interconnect points comprise pure tin.

7. (Unchanged) The method of claim 1 wherein the interconnect points comprise a metal plated with a metal comprising gold.

8. (Unchanged) The method of claim 1 wherein the bumps are stud bumps comprising Au and the interconnect points comprise Sn, and the heating step raises the temperature of the bumps sufficiently to create an alloy between the Au and the Sn in a bonding phase at the interface.

9. (Unchanged) The method of claim 8 wherein the heating step raises the temperature of the bumps sufficiently to create an alloy comprising a 80:20 Au:Sn between in a bonding phase at the interface.

10. (Unchanged) The method of claim 1 wherein the heating step raises the die to a temperature greater than about 200 °C.

11. (Unchanged) The method of claim 1 wherein the heating step raises the die to a temperature about 232 °C.

12. (Unchanged) The method of claim 1, further comprising underfilling with a polymer.

13. (Unchanged) A chip package structure made according to the method of claim 12.

14. (Amended) A chip package structure comprising

a chip having a bumps formed thereon and a substrate having interconnect points on a metallization thereon, the bumps forming contacts with the interconnect points, wherein an alloy is formed at an interface between the material of each bump and the material of the interconnect <u>contact</u> in contact with the bump.

15. The chip package structure of claim 14 wherein a cured adhesive polymer is situated in a middle region between the bump surface of the chip and the surface of the substrate.

16. The chip package structure of claim 14 wherein the bump material comprises gold and the interconnect points comprise Sn, and the alloy at the interface comprises a Au/Sn alloy.

17. The chip package structure of claim 16 wherein the alloy at the interface is a 20:80 Sn:Au alloy.